

# Assignment 3: Prompt Engineering Lab

## Introduction

Prompt engineering is the practice of designing and structuring inputs to improve the performance, dependability, and reasoning quality of generative AI systems. To generate precise and organized outputs, smaller locally deployed models require more precise guidance than large cloud-based models. This makes prompt engineering even more important in constrained local environments.

In this lab, I experimented with four progressively advanced prompting strategies using the LLaMA 3.2 (1B) model, deployed locally via Ollama:

1. Basic prompting.
2. Structured output prompting.
3. Few-shot prompting.
4. Chain-of-Thought (CoT) prompting.

## Experimental Setup

**Model:** LLaMA 3.2 (1B) deployed locally via Ollama

**Environment:** Windows terminal using Ollama runtime

**Task:** Summarization of a fixed paragraph

**Paragraph:** Artificial Intelligence (AI) is increasingly used in healthcare to improve diagnosis, personalize treatment plans, and automate administrative tasks. Machine learning models can analyze medical images faster than humans and detect patterns that may be missed by doctors. However, AI systems also raise concerns about data privacy, bias in decision-making, and lack of transparency. Proper regulation and human oversight are necessary to ensure safe and ethical AI deployment in healthcare.

### Experimental Controls:

- The same paragraph was used across all experiments.
- The same model and runtime environment were maintained.
- Only the prompt structure was modified.

## Methodology and Results

### Step 1: Basic Prompting

**Prompt Used:** “Summarize the following paragraph in 3 sentences.”

#### Observations

- The model gave a clear 3-sentence summary.
- It included the main benefits, risks, and the need for regulation.
- The summary was understandable but a little long.
- There was no specific format or structure required in the answer.

## Key Insight

Basic prompting is useful for general summarization, but it does not ensure structured extraction or logical clarity.

```
C:\Users\91824>ollama list
NAME          ID      SIZE      MODIFIED
llama3.2:1b   baf6a787fdff  1.3 GB   16 seconds ago
qwen3:latest  500a1f067a9f  5.2 GB   47 hours ago

C:\Users\91824>ollama run llama3.2:1b
>>> Summarize the following paragraph in 3 sentences:
...
... Artificial Intelligence (AI) is increasingly used in healthcare to improve diagnosis, personalize treatment plans, and automate a
... dministrative tasks. Machine learning models can analyze medical images faster than humans and detect patterns that may be missed
... by doctors. However, AI systems also raise concerns about data privacy, bias in decision-making, and lack of transparency. Proper
... r regulation and human oversight are necessary to ensure safe and ethical AI deployment in healthcare.
...
...
Here is a 3-sentence summary of the paragraph:

Artificial Intelligence (AI) is being increasingly used in healthcare to improve diagnosis and treatment planning, but raises
concerns about data privacy, bias, and transparency. Machine learning models can analyze medical images quickly and detect
patterns that may be missed by doctors, but this also means AI systems must be carefully regulated to ensure safe and ethical
deployment. To mitigate these risks, proper regulation and human oversight are necessary to prevent AI from being used in ways
that compromise patient care.
```

## Step 2: Structured Output Prompting

**Prompt Used:** Summarize the paragraph using this format: Output Format:

Main Topic:

Key Benefits:

-

-

Key Risks:

-

-

Conclusion:

Paragraph:

## Observations

- The model followed the requested structure exactly.
- Benefits and risks were clearly defined.
- The output had improved granularity.

```
>>> Summarize the paragraph using this format:
...
... Output Format:
... Main Topic:
... Key Benefits:
... -
... -
... Key Risks:
... -
... -
... Conclusion:
...
... Paragraph: Artificial Intelligence (AI) is increasingly used in healthcare to improve diagnosis, personalize treatment plans, and
... automate administrative tasks. Machine learning models can analyze medical images faster than humans and detect patterns that ma
... y be missed by doctors. However, AI systems also raise concerns about data privacy, bias in decision-making, and lack of transpar
... ency. Proper regulation and human oversight are necessary to ensure safe and ethical AI deployment in healthcare.
Output Format:
Artificial Intelligence (AI) is increasingly used in healthcare to improve diagnosis, personalize treatment plans, and automate
administrative tasks.

Key Benefits:
- Improves diagnosis accuracy
- Personalizes treatment plans for individual patients
- Automates routine administrative tasks

Key Risks:
- Raises concerns about data privacy and security
- Potentially exacerbates bias and disparities in decision-making
- Requires careful regulation to ensure transparency

Conclusion: To effectively utilize AI in healthcare, it is essential to address the key benefits and risks associated with its
deployment.
```

## Key Insight

Structured prompting significantly increased clarity and categorization. By breaking down the model into defined sections, confusion was reduced, and information extraction became more systematic.

## Step 3: Few-Shot Prompting

**Prompt Used:** Example:

Paragraph: "Electric vehicles reduce carbon emissions and decrease dependence on fossil fuels. However, battery production is expensive and requires rare minerals."

Summary: Electric vehicles lower emissions and reduce fossil fuel dependence, but high battery costs and resource needs remain challenges.

Now summarize the following paragraph:

### Observations

- The model followed the structure of the example.
- The output was more concise.
- It used the same compression style as the example.
- Summary length was reduced when compared to basic prompting.

## Key Insight

Few-shot prompting worked very well. The model followed the style and structure of the provided example. This showed that even a small local model can learn how to format and organize its response simply by seeing one example.

```
>>> Example:  
... Paragraph: "Electric vehicles reduce carbon emissions and decrease dependence on fossil fuels. However, battery production is exp  
... ensive and requires rare minerals."  
... Summary: Electric vehicles lower emissions and reduce fossil fuel dependence, but high battery costs and resource needs remain ch  
... allenges.  
...  
... Now summarize the following paragraph:  
...  
... Artificial Intelligence (AI) is increasingly used in healthcare to improve diagnosis, personalize treatment plans, and automate a  
... dministrative tasks. Machine learning models can analyze medical images faster than humans and detect patterns that may be missed  
... by doctors. However, AI systems also raise concerns about data privacy, bias in decision-making, and lack of transparency. Proper  
... r regulation and human oversight are necessary to ensure safe and ethical AI deployment in healthcare.  
...  
Here is a summary of the paragraph:  
Artificial Intelligence (AI) has become increasingly used in healthcare to improve diagnosis, treatment planning, and  
administrative tasks, but raises concerns about data privacy, bias, and transparency.  
>>> Send a message (/? for help)
```

## Step 4: Chain-of-Thought (CoT) Prompting

**Prompt Used:** Summarize step by step:

1. Identify the main subject.
2. Identify the benefits.
3. Identify the risks.
4. Write a final 3-sentence summary.

Paragraph:

## Observations

- The reasoning steps were clearly defined.
- Benefits and risks were extracted accurately.
- The final summary was detailed and well organized.
- Reasoning transparency was the highest of all methods.

## Key Insight

Chain-of-Thought prompting improved reasoning clarity and reduced skipping of key information. Explicit step-by-step instructions improved the logical structure and completeness.

```
Use Ctrl + d or /bye to exit.
>>> Summarize step by step:
...
... 1. Identify the main subject.
... 2. Identify the benefits.
... 3. Identify the risks.
... 4. Write a final 3-sentence summary.
...
... Paragraph:
... Artificial Intelligence (AI) is increasingly used in healthcare to improve diagnosis, personalize treatment plans, and automate administrative tasks. Machine learning models can analyze medical images faster than humans and detect patterns that may be missed by doctors. However, AI systems also raise concerns about data privacy, bias in decision-making, and lack of transparency. Proper regulation and human oversight are necessary to ensure safe and ethical AI deployment in healthcare.
Here is a step-by-step summary:
1. Identify the main subject: Artificial Intelligence (AI) in Healthcare
2. Identify the benefits:
- Improves diagnosis accuracy
- Personalizes treatment plans for individual patients
- Automates routine administrative tasks
3. Identify the risks:
- Raises concerns about data privacy and security
- Potentially exacerbates bias and disparities in decision-making
- Requires careful regulation to ensure transparency
4. Write a final 3-sentence summary:
Artificial Intelligence (AI) in healthcare is increasingly being used to improve diagnosis, personalize treatment plans, and automate administrative tasks, but it also raises concerns about data privacy, bias in decision-making, and lack of transparency. Proper regulation and human oversight are necessary to ensure safe and ethical AI deployment in healthcare. To effectively utilize AI in healthcare, it is crucial to address the benefits and risks associated with its use.
>>> |Send a message (/? for help)
```

## Comparative Analysis

The table below summarizes the performance differences observed among the four prompting strategies.

Prompt Type	Accuracy	Structure	Completeness	Reasoning Depth
Basic	High	Low	Moderate–High	Moderate
Structured	Very High	Very High	High	High
Few-shot	High	Moderate	Moderate	High
CoT	Very High	High	Very High	Very High

The results clearly show that prompt engineering has a significant impact on the performance of smaller local models like LLaMA 3.2 (1B).

- Structured prompts improve accuracy and clarity.
- Few-shot prompts improve style consistency.
- Chain-of-Thought prompts improve logical reasoning and completion.

- Basic prompts are adequate for general summarization but lack control.

The experiments show that smaller models benefit significantly from explicit guidance, and structured prompting strategies help to reduce complexity and improve output consistency.

## Real World Applicability

Application	Recommended Strategy
<b>Information extraction</b>	Structured prompting
<b>Customer support summaries</b>	Few-shot prompting
<b>Educational tutoring</b>	Chain-of-Thought
<b>Quick summaries</b>	Basic prompting

Local AI deployments require prompt engineering to achieve acceptable performance levels.

## Conclusion

This lab demonstrates how prompt engineering improves the performance of smaller local models like LLaMA 3.2 (1B). While basic prompting resulted in generally accurate summaries, more structured and guided techniques significantly improved responses. Structured prompting improved clarity and organization, while few-shot prompting improved consistency by guiding the model with examples. Chain-of-Thought prompting produced the most complete and logically detailed outputs.

The results highlight that smaller models benefit greatly from explicit instructions and carefully designed prompts. Overall, this experiment shows that effective prompt engineering is critical for improving accuracy, structure, and reasoning quality in locally deployed AI systems.